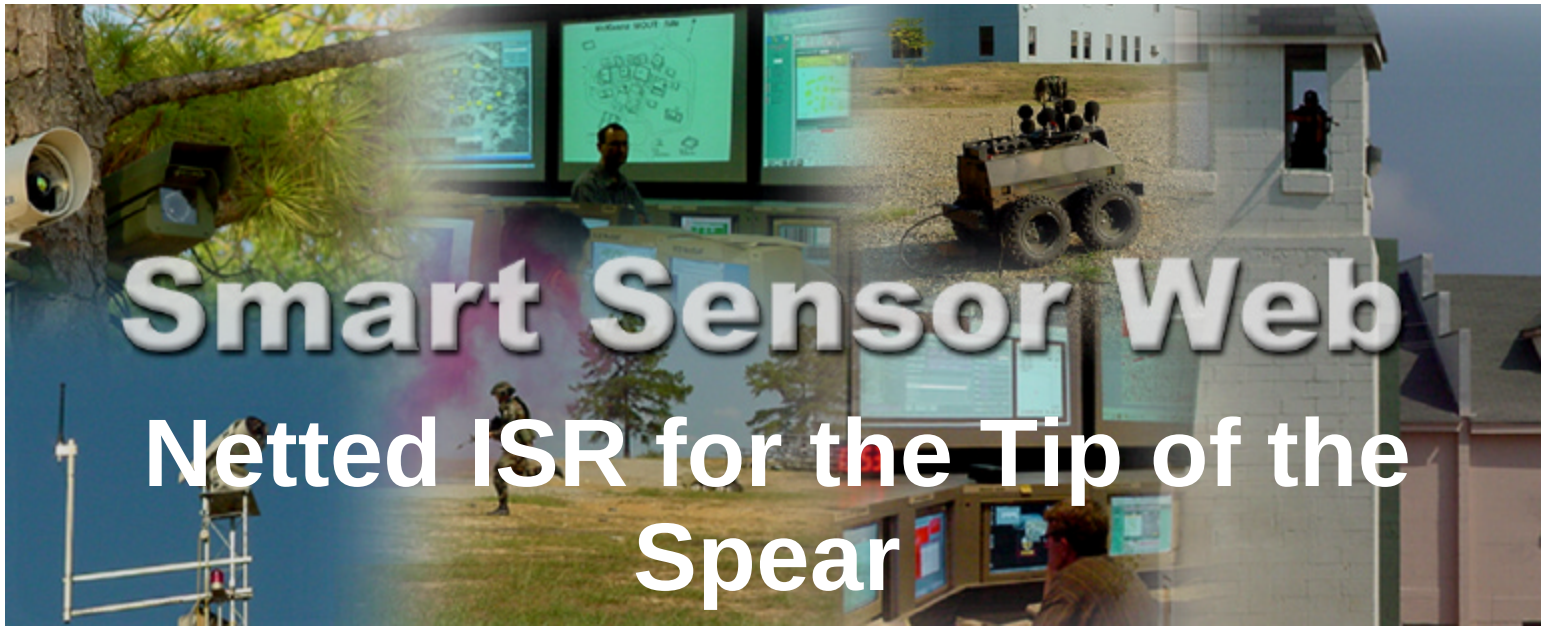


Netted ISR for the Tip of the Spear

14 March 2002

Lt Col Eileen Bjorkman
Smart Sensor Web Project Manager
Defense Modeling and Simulation Office

Outline

- Background
  - DUSD (S&T) Thrusts
  - Vision
  - Objectives
  - Key Technical Elements
  - Test Beds
- Experiments and Results
- Conclusions

DUSD (S&T) Thrusts

- **Five thrust areas**
  - **Smart Sensor Web**
  - **Cognitive Readiness**
  - **Chemical and Biological Defense**
  - **Information Assurance**
  - **Hardened and Deeply Buried Targets**
- **Objectives of thrust areas**
  - **Develop an understanding of critical technical & operational issues associated with each thrust area**
  - **Demonstrate system concepts**
  - **Transition to Services**

Primary Objective of the Thrusts: Accelerate the development and transition of the capability to the user

Smart Sensor Web

Vision: **An intelligent, web-centric distribution and fusion of sensor information . . . that provides greatly enhanced situational awareness, on demand, to warfighters at lower echelons.**

"… extracts information from large arrays of local sensors joined with other assets: imagery, weather, weapons, simulations, the world-wide-web, etc. . . ."

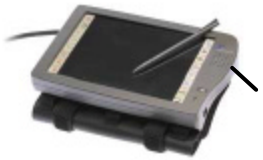
Program Objectives

- Identify and examine, in depth, the critical technical issues associated with the development of an enhanced situational awareness system for the lower echelon fighter
  - Identify technical issues in an operational context
  - Develop an assessment capability
  - Identify transition opportunities

Goal was to examine technical issues in an operational context, not to develop a prototype system.

Operational Context

- Deployable system
  - No large infrastructure--batteries/wireless internet
- Usable by individual soldier
  - Lightweight/wearable
  - Compatible with CB gear
  - Daytime/nighttime
  - Rugged
  - Does not interfere with mobility
  - Information tailored to soldier's needs
- Security
  - Not easily detected, intercepted, or jammed
- Versatile
  - Works in urban as well as open terrain
- Interoperable
  - Exchange information with other Services

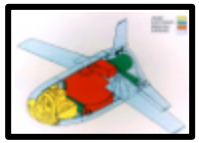


Information Integration Concept

- infrared, Visual imagery

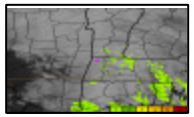
Image Web

- Enemy vehicle Location



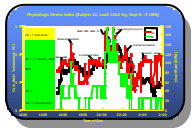
Weapons Web

- Forecast, nowcast, wind direction & speed



Weather Web

- Soldier health status



Physio-Web

- 3-D Simulated view for mission planning

Simulation Web

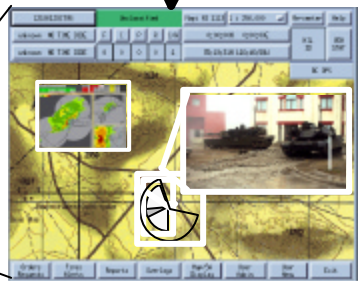
- Blue & Red force locations; maps; building plans

MOUT Infra-Structure

RF Comms

Information Integration

Profiled
- Soldier
- Fire-team
- Squad
- Platoon
- Company
- Battalion



Integrated Display

Different Users' Needs

Mission Planning

- Process
  - Deliberate process
  - Development of operations order
  - Development of contingency operations
  - Plan and conducting rehearsals
- Products
  - General & specific knowledge of assigned area
  - Summary of recent red force and civilian activity
  - Current red force and civilian location and activity, as well as obstacles

Heavy volume of information
Time in minutes/hours

Mission Execution

- Process
  - Fast paced execution of plan
  - Very little reaction time
  - High stress environment-mental and physical
  - Heavy reliance on battle drills
- Products
  - Specific knowledge of assigned area
  - Specific Blue force location
  - Red force and civilian tracking and activity

Primarily information updates
Time in seconds/minutes

User Information Profiles

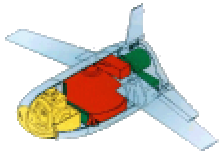
The key is understanding the geographical and temporal needs of warfighters of various echelons

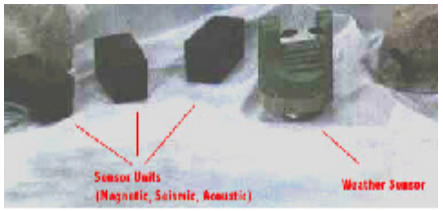
Company Commander

Fire Team Leader

Key Technical Elements

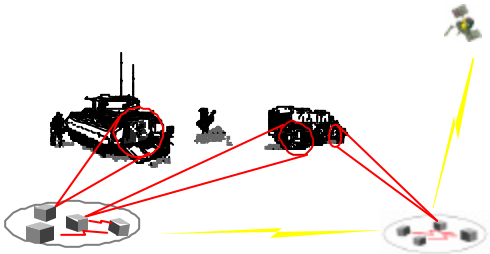
Information Sources





- Energy efficiency
  - Low power designs
  - Cued architectures
- Smart local processing
  - Tracking (VSAM)
  - Recognition
  - Compression
- Local sensor information aggregation
  - Collaborative processing

Information Architecture



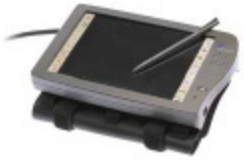
- Efficient bandwidth utilization
  - Efficient formatting
  - Better protocols
- Energy efficiency
  - Radios
  - information aggregation
- Security protection
  - Authentication
  - LPI/LPD

Information Management

Battalion TOC

- Fusion of heterogeneous information
  - Acoustic, image, seismic, magnetic
  - Geo location & temporal matching
- Information validation
  - Red force input
  - Red force persistence
- Data base query

Information Presentation



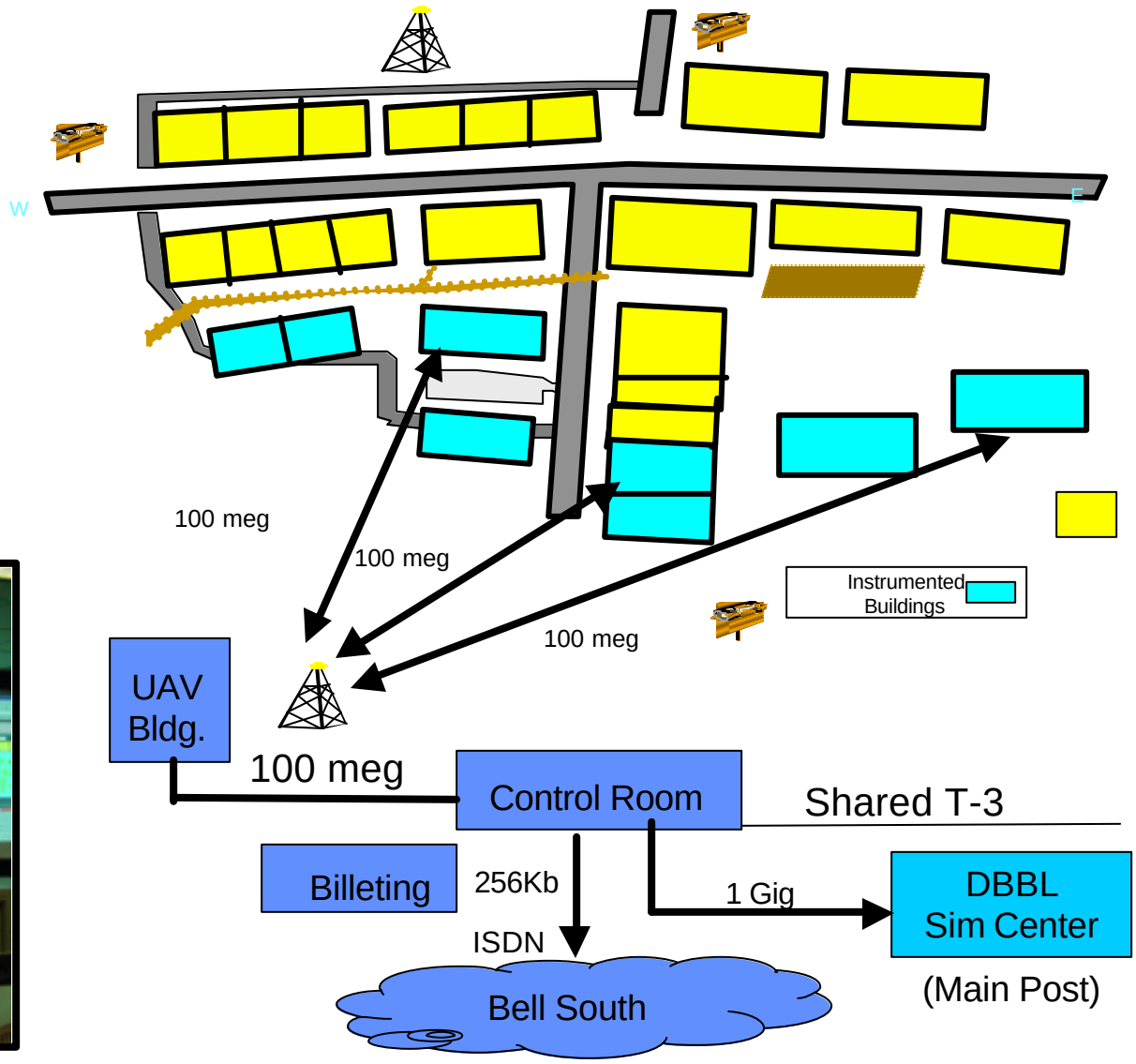
- Correlated presentation
  - Map
  - Sensor Field
  - Image
- Optimization of presentation medium
  - Voice
  - Text
  - Imagery
- User profiling
- 3D Presentation
- Prioritization

Testbed Concept

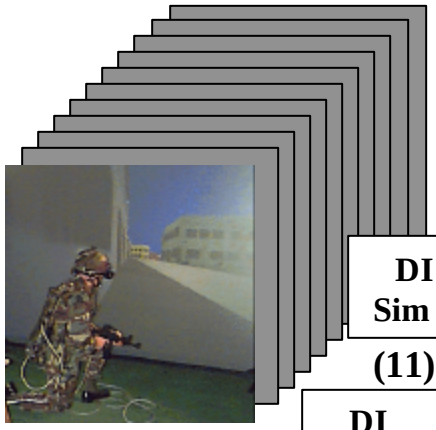
- **Single testbed, with both virtual and live simulation components**
- **Virtual testbed:**
  - **Pre-mission planning**
  - **3D visualization tools**
  - **Augment exercises with additional forces**
  - **Other operational assessments**
- **Live testbed:**
  - **Ground truth**
  - **Realistic operational environment**
  - **Data for model development and validation**

Live/Virtual Testbed--Ft Benning

McKenna MOUT Site



Squad Synthetic Environment



SSE
DI Simulator x 9

DI Sim 5

(11)

DI Sim 4

DI Sim 3

DI Sim 2

DI Sim 1

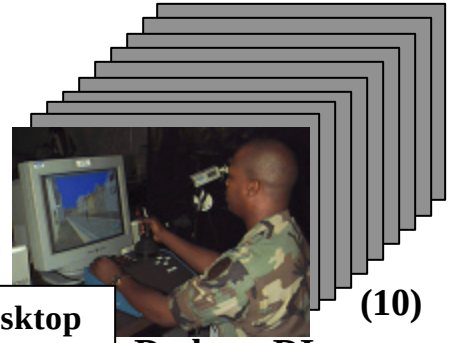
DI Sim 6

DI Sim 7

DI Sim 8

DI Sim 9

Simulation Center
Fiber Network



Desktop DI Sim

(10)

Desktop DI Simulator

DI-SAF
ModSAF/OneSAF
OPFOR

DI-SAF
ModSAF/OneSAF
BLUFOR

DI SAF

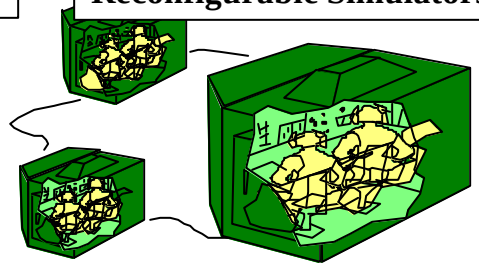
Support Equipment

Support Equipment

MOUT Database

Land Warrior
Functionality

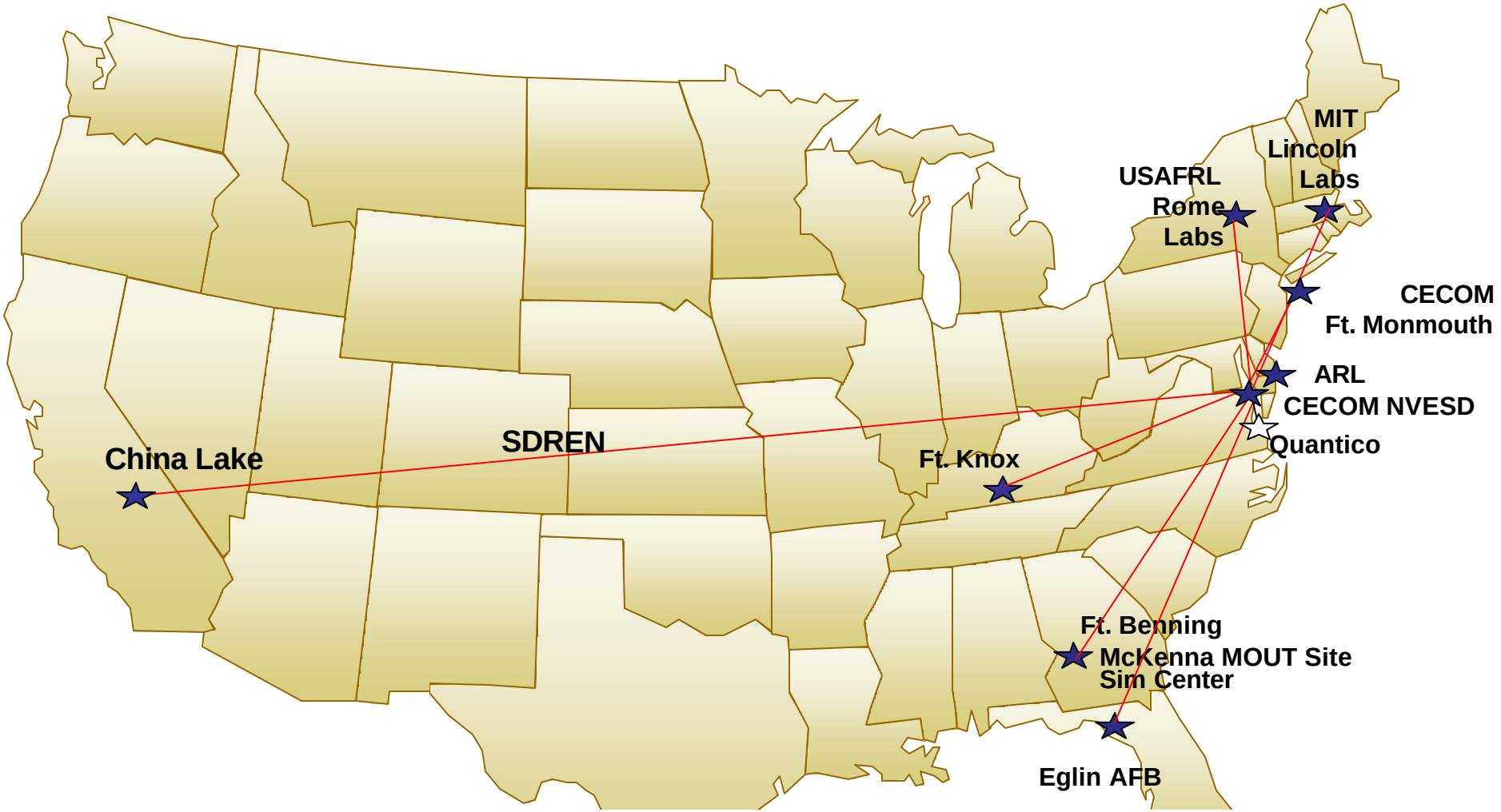
High Fidelity Vehicle &
Reconfigurable Simulators



Desktop Aviation Simulator

Squad Synthetic Environment

SSW Virtual/Distributed Testbed



Outline

- Background
- Experiments and Results
  - Live Experiment #1, August 2000
  - Live Experiment #2, January 2002
  - Virtual Experiments
  - Cooperative Attack Experiment
- Conclusions

Live Experiment #1, August 2001

- Three scenarios
  - Non-combatant rescue with SOF support
  - Personnel Recovery with SOF support
  - LOCAAS support
- Squad size element with platoon leader
- Squad augmentation by simulation
- HRED assessment
- Significant integration problems
- Some improvement in SA
- Positive troop feedback

Live Experiment #2, January 2002

- Experiment 1- August 2000
- Three scenarios
  - Non-combatant rescue with SOF support
  - Personnel Recovery with SOF support
  - LOCAAS support
- Squad size element with platoon leader
- HRED assessment
- Significant integration problems
- Some improvement in SA
- Positive troop feedback

- **Experiment 2- January 2002**
- **One scenario**
  - **Non-combatant rescue**
- **Platoon size element with company commander**
- **Platoon augmentation by simulation**
- **HRED assessment**
- **Correct integration deficiencies**
- **Measure increased SA**
- **Evaluate troop feedback**
- **Augmented by Virtual Experiments (through June 2002)**

Live Experiment #2: Three Technology Levels

- Baseline – Equipment Available Today
- Technology Level I – Capability in 2-5 Years
- Technology Level II – Capability in 5-10 Years

White Board

SSW User Application

Imaging Sensors

UAV w/Real Time Video

3-D Fly Through

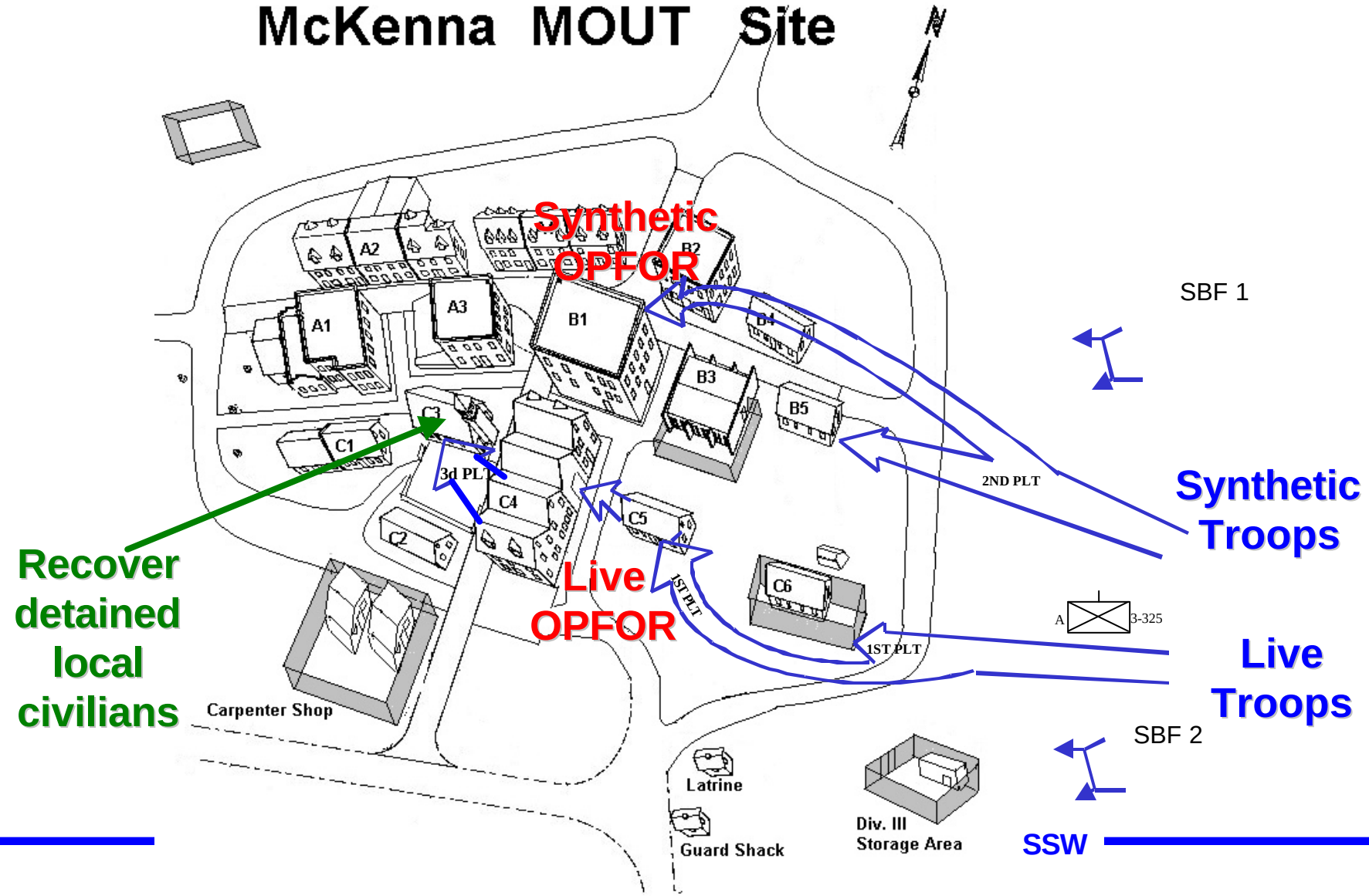
Non-Imaging Triggers

+

MOUT Infrastructure Cameras

UGV with OmniVision Camera

Live Experiment #2 Scenario



Live Experiments – Technical Issues

- **Blue Force Location**
  - GPS errors of 5m-10m are significant for dismounted warfighter
    - » Working approach to keep blue icons in/out of buildings as appropriate
  - GPS in buildings an issue
    - » Satellite reception
    - » 3D location
- **Network connectivity**
  - Breaks off in forests surrounding MOUT site
    - » RF Card Comms not very strong
- **Delivery of information**
  - "Smart" is most important part of Smart Sensor Web
    - » Can't overload warfighter with lots of images
    - » Currently rely on humans-in-the-loop
  - Latency has to be minimal

Live Experiments – Technical Issues

- **Wearable computer configuration**
  - **Too bulky**
  - **Display -- daylight reading problems & violates OPSEC at night**
    - » **Need more than visual interface -- Warfighters don't have time to view screen during assault phase**
  - **Battery life**
  - **Cables**
    - » **Bluetooth is a potential solution**
- **Availability of 1m resolution databases of cities of interest**
  - **Simulations of great value for mission planning/rehearsal**
- **Emplacement of sensors**
  - **Especially those in buildings**
  - **Effects of weather on low altitude light UAVs**
    - » **Stabilization of image**

Live Experiment #2 – Overall Results

- **Marked increase in situation awareness – over 100%**
- **Soldiers developed new procedures during experiment; existing TTPs do not address the use of situation awareness systems**
  - Information most useful during mission planning and pre-assault phases
- **Information presentation needs work**
  - Too much video
  - Not enough pre-processing, correlation, fusion
- **Bandwidth acceptable, except for multiple access of streaming video**
  - TCP/IP high overhead, maybe not suitable for tactical systems
- **Testbed generally suitable, needs work on TSPI accuracy and weapons effects**

Virtual Experiment -- Four Phases

- Critical Information Requirements for Platoon and below
- The effect of information display modality on situation awareness of infantry soldiers
  - Still image
  - Streaming video
  - Audio
  - Map display
- The effect of information accuracy on situation awareness of infantry soldiers
- The effect of sensor mix and density on situation awareness of infantry soldiers

All experiments done with NVESD Simulation, the DBBL Squad Synthetic Environment (SSE), and HRED

Critical Information Requirements Study

- User needs
  - What information does a soldier need?
    - » What does he need as a function of echelon?
    - » What are geographical needs?
    - » What are temporal needs?
    - » What does he need at pre-mission/pre-assault planning and rehearsal?
    - » What does he need during the assault?
- Information value
  - How useful are the various elements of information to the soldier in accomplishing his tasks?
    - » In enhancing situational awareness
    - » In supporting planning, mission rehearsal, decision making, mission execution, survivability
  - How should information be prioritized/presented to the soldier?

SSW identified Critical Information Requirements (CIRs) for Infantry platoon and below operating in urban areas during attack, defend, and reconnaissance missions.

Critical Information Requirements

- Army Research Laboratory, Human Research and Engineering Directorate
- Three vignettes with three scripts each from prior live exercise
  - Clearing a building after attacking across an open danger area
  - Defensive preparation for counterattack while occupying second floor of a building
  - Reconnaissance mission to observe OpFor activity
- Evaluated four echelons
  - Squad member
  - Team leader
  - Squad leader
  - Platoon leader
- Eight squads total

Squad	Vignette A			Vignette B			Vignette C		
	Scr 1	Scr 2	Scr 3	Scr 1	Scr 2	Scr 3	Scr 1	Scr 2	Scr 3
1	X			X			X		
2	X			X			X		
3	X			X			X		
4		X			X			X	
5		X			X			X	
6		X			X			X	
7			X			X			X
8			X			X			X

Critical Information Requirements Validation Phase

PURPOSE: To ensure that the cognitive data collected in the simulator is comparable to data collected in a live environment

RESOURCES:

- One Platoon
- One day
- One vignette with two scripts

METHODOLOGY: Comparison of criticality ratings from live vignettes to those from simulator vignettes

Critical Information Requirements Validation Results

Priority	Information Requirements Live	Mean	SD	Information Requirements Simulation	Mean	SD
1	OpFor location on objective	5.28	1.35	OpFor location on objective	6.04	1.30
2	Counterattack threats and location	5.08	1.17	Counterattack threats and location	5.62	1.42
3	Type of hostile fire expected from SE	4.99	1.32	Platoon sergeant location	5.52	1.46
4	OpFor location outside McKenna	4.92	1.19	Type of hostile fire expected from SE	5.50	1.43
5	Company CCP location	4.83	1.16	OpFor location outside McKenna	5.36	1.29
6	OpFor activity reported by A Co.	4.69	0.94	Disposition of 2nd Squad	5.34	1.27
7	Platoon sergeant location	4.66	1.30	OpFor activity reported by A Co.	5.32	1.46
8	OpFor element rate of movement	4.64	1.26	Anticipated time OpFor will reach McKenna	5.13	1.50
9	Anticipated time OpFor will reach McKenna	4.62	1.20	OpFor element rate of movement	5.09	1.43
10	Disposition of A Co	4.40	1.29	Company CCP location	4.98	1.65
11	Disposition of 2nd Squad	4.39	1.11	Disposition of A Co	4.79	1.40

Criticality Rating: 1-7, with 5-7 being necessary for mission performance

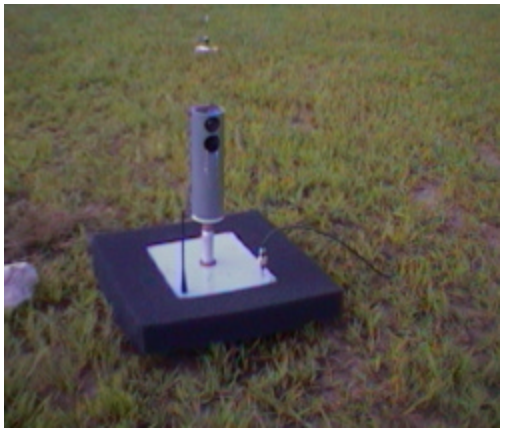
Critical Information Requirements Results

- Information deemed slightly more critical in simulator vs live
- Squad members needs less information than higher echelons due to the very localized types of decisions they make
- Criticality of OpFor location beyond 50 meters from the objective increases as the level of leadership increases. Leaders interested in information out to 1 km
- Simulator limitations may have a modest impact on outcome; e.g., simulated OpFor may not appear as threatening as live OpFor

Cooperative Attack Experiment

1. Enhanced weapon performance.
Demonstrate that WASM's can use off-board sensor information in addition to on-board sensors and inter-weapon communications to enhance overall effectiveness.

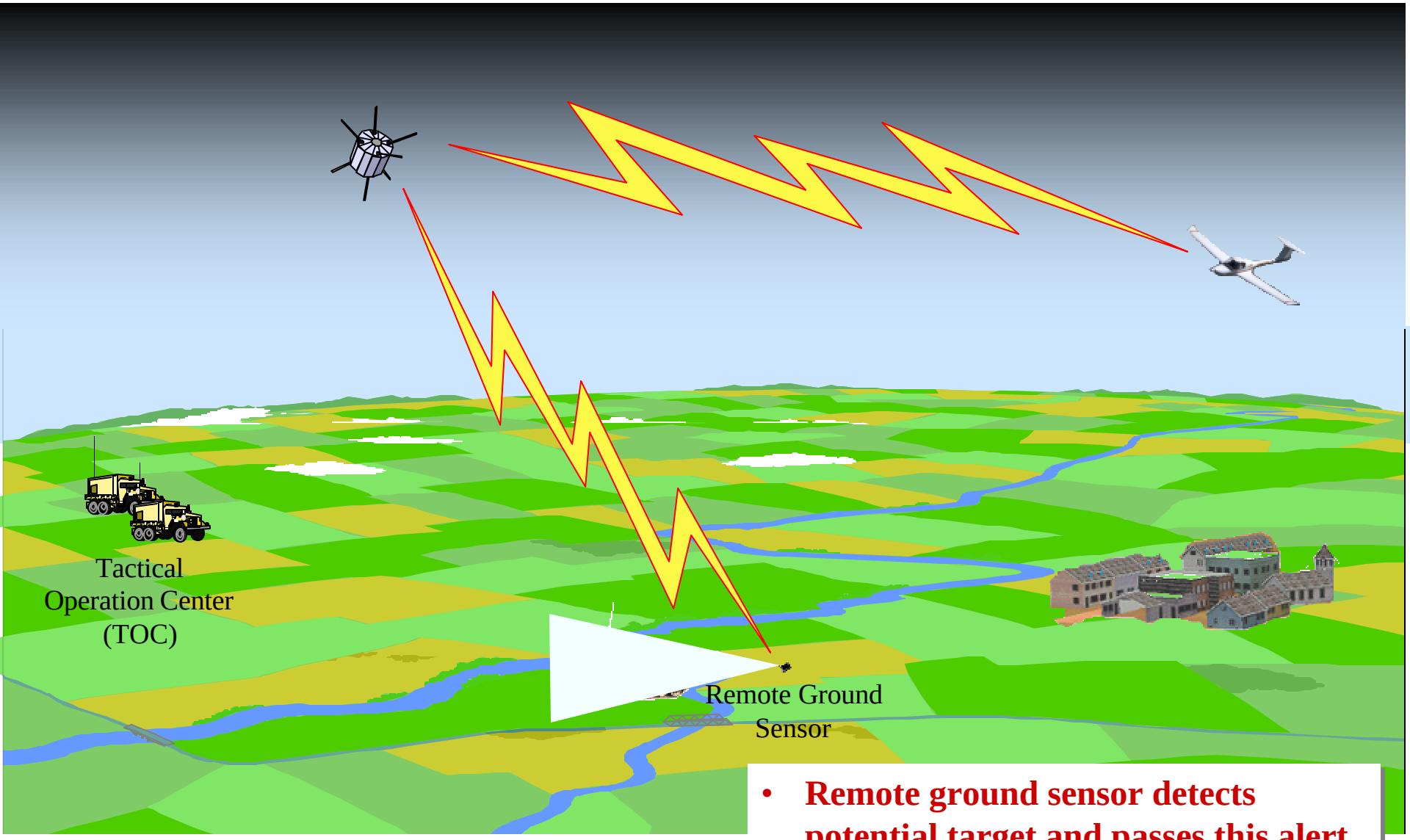
2. Informed battlefield decisions.
Demonstrate that munitions can provide important data (target recognition, damage information or snapshot images) to the SSW for use by battlefield decision makers.



"Tanks Under Trees" Sensor

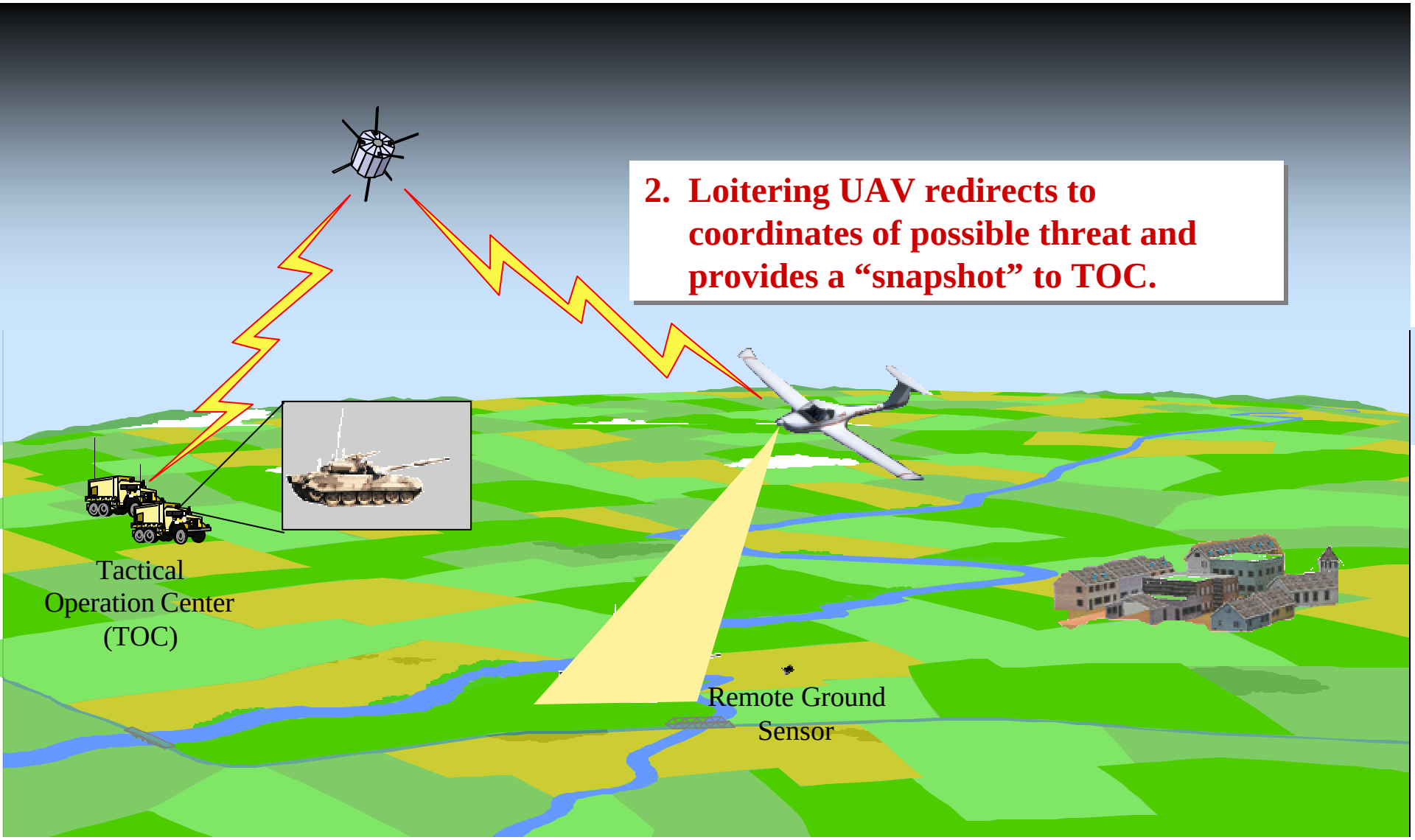
Low Cost Autonomous Attack System (LOCAAS)

Cooperative Attack Experiment

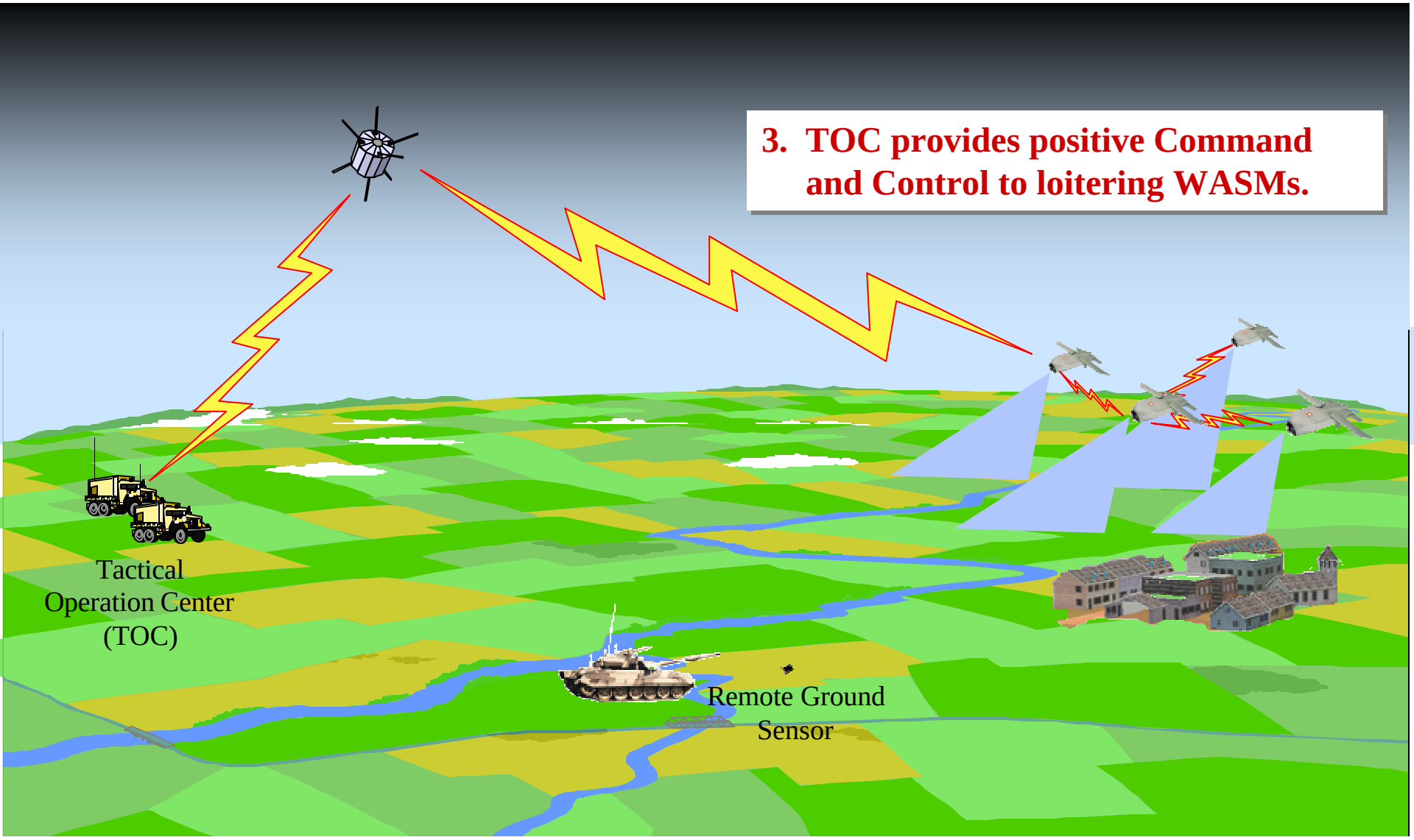


- **Remote ground sensor detects potential target and passes this alert to a loitering UAV.**

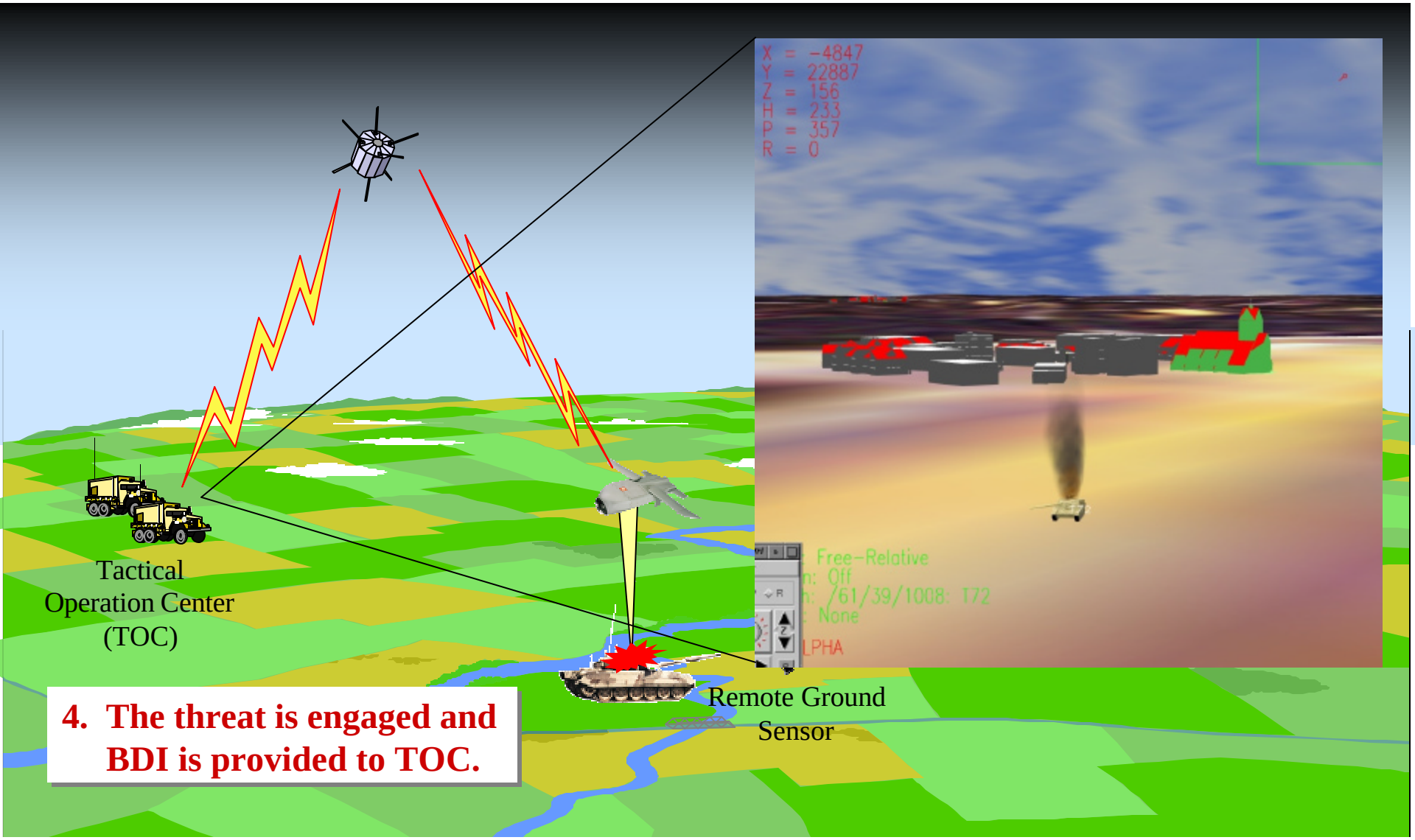
Cooperative Attack Experiment



Cooperative Attack Experiment



Cooperative Attack Vignette



Outline

- Background
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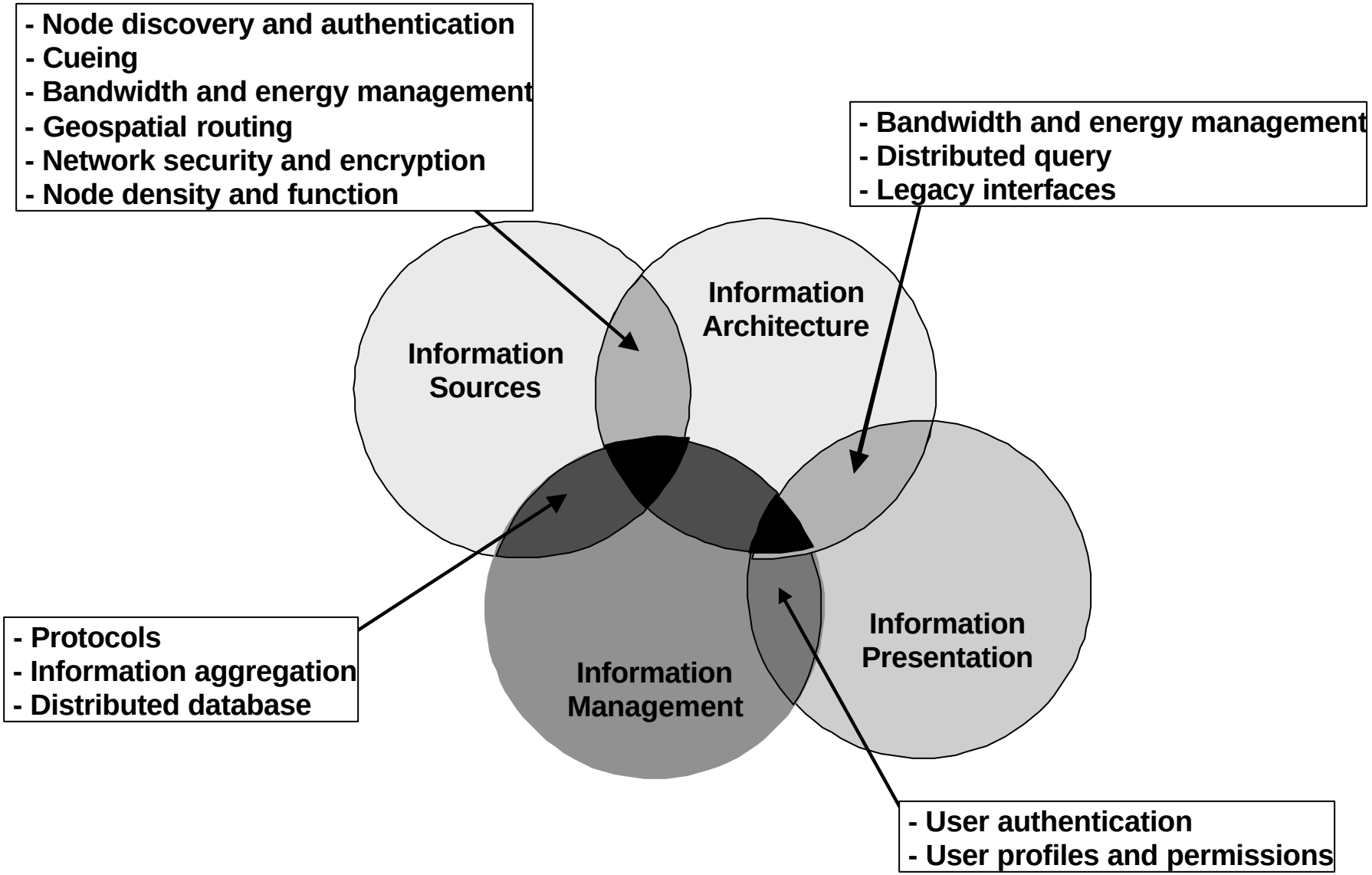
Conclusions

- Soldiers at the lowest echelons can exploit information in real time to enhance force security and improve small unit operations effectiveness
- Integration and fusion of information in real time needs improvement
- Cooperative attack experiment highlights the potential for lower echelon warfighters to use higher echelon assets on the battlefield
- Testbeds are available and suitable for follow-on development work

BACKUPS


- Node discovery and authentication
- Cueing
- Bandwidth and energy management
- Geospatial routing
- Network security and encryption
- Node density and function
- Bandwidth and energy management
- Distributed query
- Legacy interfaces
Information Sources
Information Architecture
Information Management
Information Presentation
- Protocols
- Information aggregation
- Distributed database
- User authentication
- User profiles and permissions

Critical Technical Issues
Information Architecture

- Energy and bandwidth management:
  - **What is the energy cost of moving information from sensors to users**
  - **What bandwidth is required to meet information needs?**
  - **What network mechanisms can be employed to minimize energy and bandwidth utilization?**
- Network layer:
  - **What drives node density, sensing or communication?**
  - **How does a random distribution of nodes form and maintain a network?**
  - **How does a user access information without knowledge of the network?**
- Information aggregation:
  - **Where does information reside in the network?**
  - **How and where is heterogeneous sensor information combined?**
  - **What is the value of information aggregation to efficiency and to successful detection and classification?**

Critical Technical Issues
Information Management

- Interfaces to Sources
  - **What are the relevant sources of information?**
  - **What are the data formats that facilitate integration into SSW?**
  - **What is the essential information to be extracted from a source?**
- Storage
  - **Where is the best place to store data and should it be replicated?**
  - **How should the data be organized? -- Relational?, object-oriented?, XML?, jpegs?, streaming video?, formats?**
- Fusion Processes
  - **What types of fusion are useful and can be implemented?**
  - **How do we handle information validity decay?**
  - **What are the fusion processing latencies? -- Accurate vs. fast?**

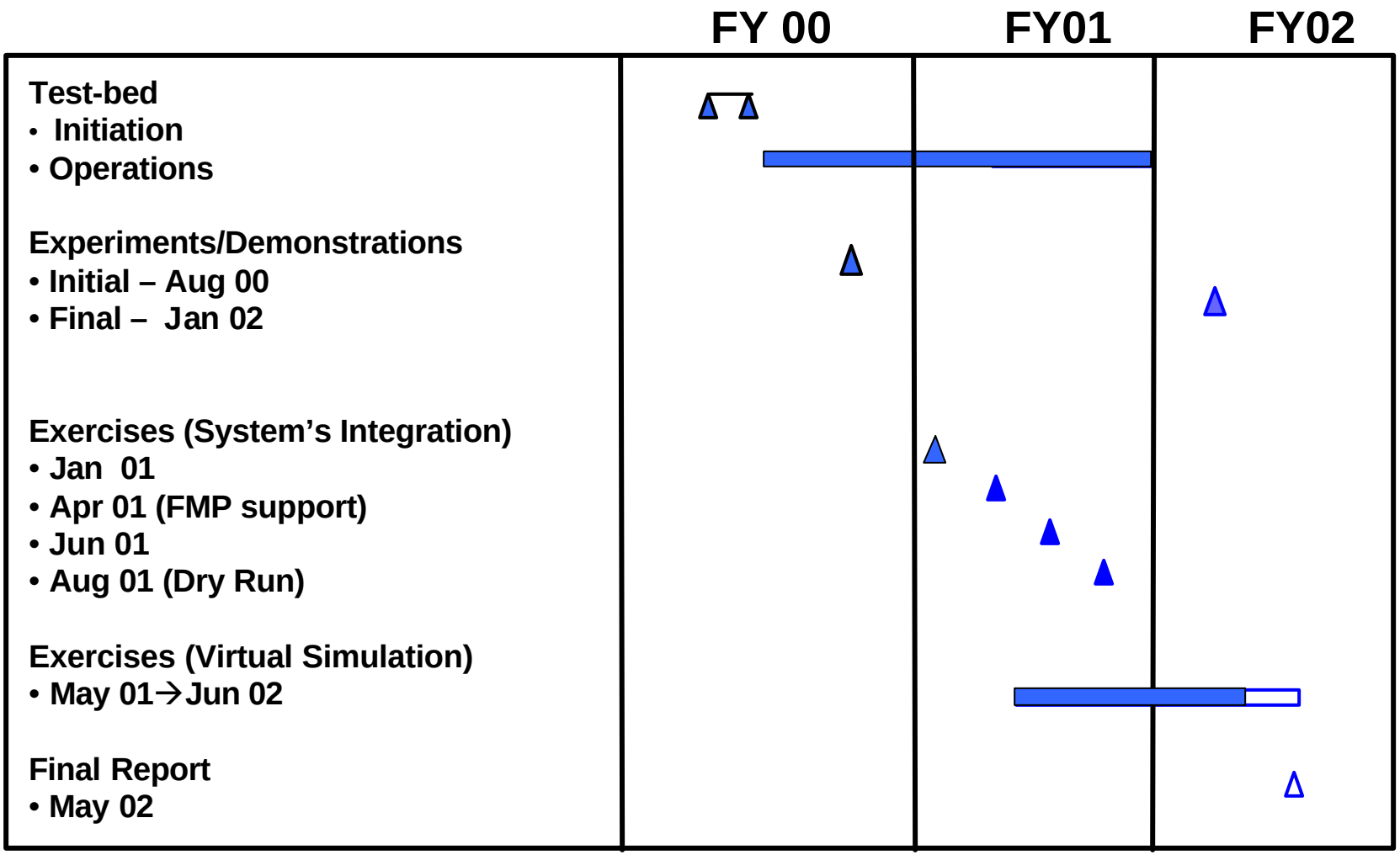
Critical Technical Issues
Information Management, cont.

- Reference Data
  - **What are the relevant sources of reference or background data?**
  - **What are the relevant formats and interfaces to acquire reference data?**
  - **What data should be stored in the database?**
  - **What data should be downloaded to the soldier devices?**
- Interface to User Presentation
  - **What are the formats to support information push and pull?**

Critical Technical Issues
Information Presentation

- Presentation modalities
  - **What is the best way to inform a soldier of the current situation?**
    - » **Situation dependent, echelon dependent**
  - **What are the display requirements for ease of use?**
  - **What are the relevant human factors issues for soldier displays?**
  - **How do individual soldiers report enemy activity quickly, easily, and accurately?**
  - **What's the best way to acquire and present reference data?**
- Information Flow Control
  - **How should the flow of information to soldiers at different echelons be controlled?**
  - **How is the flow control established and implemented?**

Program Schedule



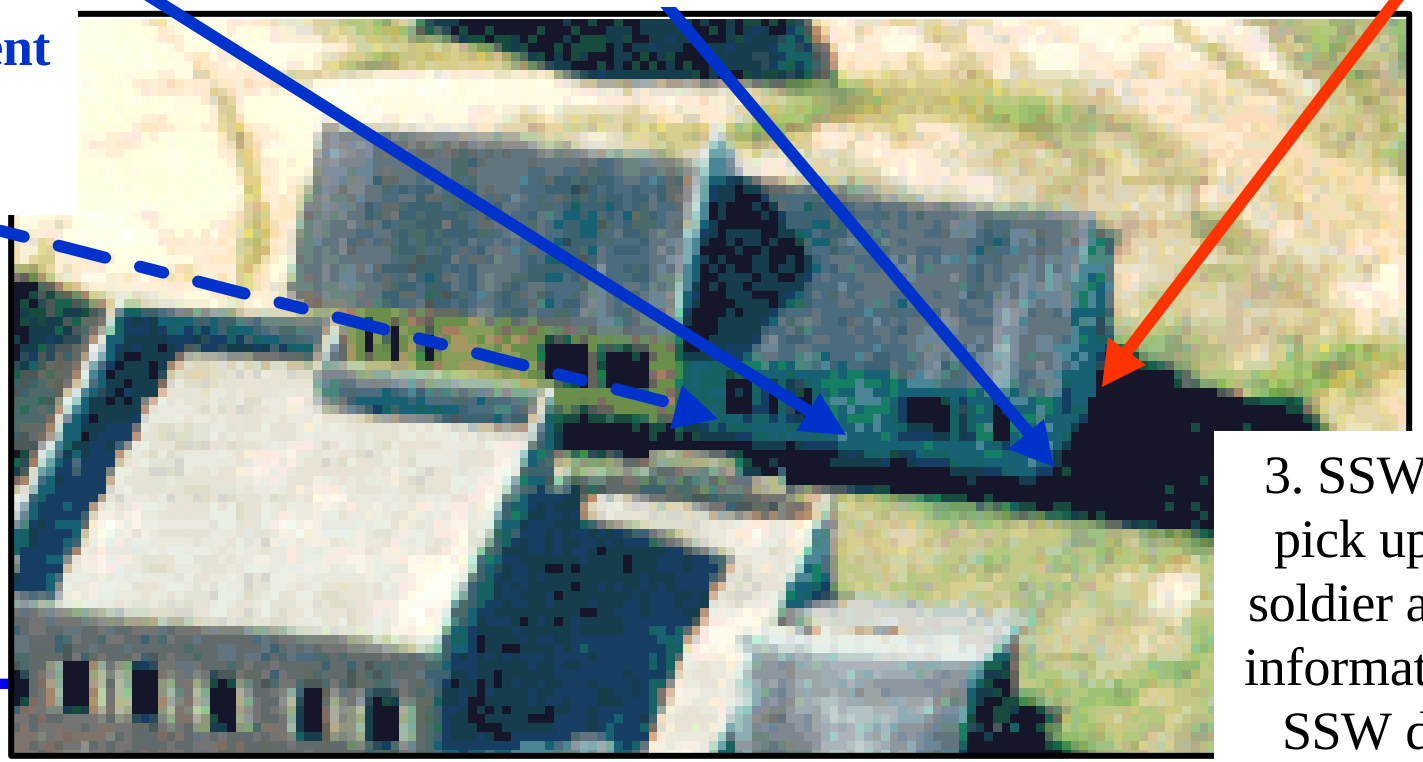
Example of Value of SSW Information

5. Blue Forces see potential enemy soldier around corner. Fire Team Leader uses personal camera to look around corner and verify enemy soldier. Fire Team then goes around corner and kills Red Soldier with no friendly casualties.

4. Blue Forces stop in front of building ready to enter, but check display first

2. Red Soldier moves to position outside building to shoot through window at blue soldiers entering building.

1. Movement of Blue Forces



3. SSW sensors pick up enemy soldier and sends information to all SSW displays